Introduction

KC901S is a multimeter for radio-frequency that supports both vector network analysis of one port and scalar network analysis of two ports. With extensional functions of spectrum, field strength and signal projector, the maximum practicality has been got.

◆Main Features*

The frequency range is as high as 3GHz

The Stepped frequency of entire domain is 1Hz

Good accuracy and stability

Double-conversion and high anti-interference ability

Abundant functions and convenient to carry

The fruits of wisdom of the community **

◆Main Functions

Transmission measurement (filter adjustment, amplifier measurement and directivity measurement of antennas)

Reflection measurement (adjusting impedance matching network and examining quality of antenna feed system)

Measurement of Low frequency signal source and radio frequency signal source

Spectrum display and field strength detection*** (inspecting radio station emission performances and searching for interference sources)

◆Recommended Applications

KC901S is designed for adjusting RF circuits, such as filter, amplifier, splitter, combiner, for testing input and output impedance, evaluating the quality of antenna feed system, and for detecting signal amplitudes of equipment at all levels. In some bands, field measurement, and detection of interference are allowed.

When combined with community exchange, KC901S is a good tool to learn radio frequency knowledge. In the area of expertise, it can be applied in professional Communication Engineering, antenna manufacture and daily maintenance of broadcast and TV radiating stations, promoting working efficiency, ease carrying burden as well as improve quality of works.

◆Acceptance and Check

When receive the product, it is necessary to confirm the integrity of package. First step is to read introduction of user manual and check the equipment.

A standard packing includes:

KC901S 1

Charger 1

Strap 1

User manual 1

Check up all items, and make sure of no damaged appearance. Examine whether screws of KC901S loose and unusual sound heard when

shaking.Without any exceptional cases, the charger should be connected before starting up. If the battery is installed, press POWER for 0.5 second for start-up inspection.

◆Safety Notes

KC901S is not a kind of consumer goods, so the users should be professionals or be acquainted with professional knowledge of this field.

In this user manual:

Notice indicates inaccurate measuring results or ordinary risks.

Warning indicates possible personal injuries, serious risks, equipment damage or other serious consequences .

Warning

When water intake, unusual sound, or other obvious abnormal is observed, do not start it up.

During thunderstorms, it must not be used to measure any outdoor equipment including that with lightning arrestor.

Pay attention to grounding of DUT to prevent electric shock. Equipotential touching is necessary before connection to avoid unequal potential damages to the apparatus and DUT.

Charging must be under surveillance. It must be far away from inflammables and explosives when working or charging. Do not cover the equipment or charger.

Take notice of the temperature range of storage and usage. Do not place it

in the vehicle under sun exposure.

KC901S must not be used for any illegal purposes. People with intrusive electronic equipment should use it with caution. It is better to avoid using it in hospitals, airports and other sensitive positions.

KC901S must be carried with when the user takes a plane. Make sure that the antenna is taken off, field mode is set and power is off. Please obey the local laws and any specific rules in the airport.

The maximum battery capacity of KC901S is 60Wh. It is necessary to choose qualified batteries and to be careful of the risk of lithium battery. Please place it out of the reach of children. When KC901S is lent, the user should urge the borrower to read user manual and inform the borrower of safety notes.

◆Important Statement

KC901S is not a commercialized product that meets the demands for appearance and details of all users. The manufacturing technical indexes and the third party certification affirm the designing and manufacturing capability rather than provide any guarantee for users. Even though we have done our best to make it practical, convenient and useful, defects still exit. We are willing to take your suggestions.

To the full extent of the law, Kexinshe is not responsible for the loss beyond the prize of KC901S under any circumstances. We take no

responsibility for any indirect loss and losses in terms of time, business, inconvenience, profit and abuse. Maintenance, replacement or returning product and refund are the only remedial measures we can take. Kexinshe only take responsibility for the product within the guarantee period.

Under any circumstances, we do not guarantee its applicability, reliability and security for purposes of commerce, industry and military. We do not admit any promise made by dealers.

* Please read technical instruction.
** Support communities: bbs.kechuang.org , hellocq.net
*** Informal function
The lasted version can be downloaded in measall.com

Chapter One Installation Guide

KC901S does not have installed batteries when it leaves the factory. The battery will be installed either by the dealer or by the user. Before the battery is installed, please supply power with power adapter and begin start-up inspection. If KC901S functions are all normal, shut it down and pull out the power adapter, and then install batteries.

1.1 How to choose batteries

Lithium-ion batteries apply to KC901S. For a single battery, the charging cut-off voltage is 4.2V, and the discharging cut-off voltage is 2.6V. With the voltage rating of 3.6-3.7V, batteries are connected in two parallels and two series. The power management circuit has the functions of overcharge protection, over-discharge protection, balance protection and short-circuit protection.

The battery compartments are appropriate for cylindric lithium batteries with a diameter of 18mm and a length of 65mm also known as 18650 cell. The batteries must meet the industry demands.

Although KC901S works on two or four batteries, four batteries are preferred. The rated charging current of KC901S is 1A. If two batteries are put in, for a single battery, the peak charging current is 1.2A, and the peak discharging current is 1.5A. If four batteries are put in, the current will be a little higher than half of that.

The batteries must be the same type and simultaneously produced. Before

they are put in, the voltage of every battery should be basically the same, and the difference is not higher than 50mV. Otherwise, the batteries should be equalizing charged or discharged prior to using.

The usage of batteries should be based on the instruction. General speaking, low temperature resistant batteries are used in winter. When the ambient temperature is over 45 ℃, the battery temperature will be higher than 65℃ due to the heat produced by the circuit. Therefore, it is necessary to choose high temperature resistant batteries.

1.2 How to Install Batteries

Tools needed: a hexagon screwdriver with the diameter of 2mm

Step 1: put KC901S flatwise in the workbench, and take down the two screws from the tail(Chart1-1).

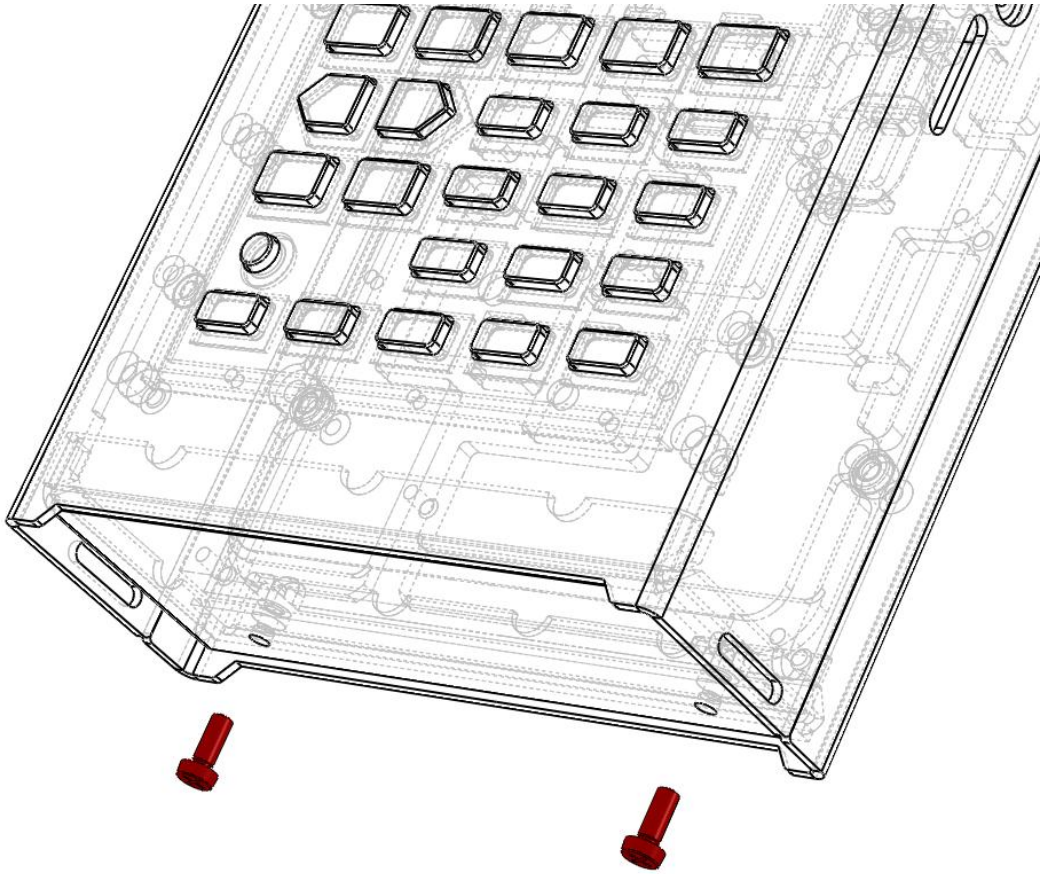

Chart 1-1:Step 1

Step 2: Pull the chassis from keyboard to tail for 2cm(Chart 1-2).Hold two sides of the upper chassis with fingers, and meanwhile pull the RF joints. It is a good idea to knock the tail in the lower chassis when difficulty occurs. Do not overexert and pull less than 4cm in case of the fracture of interior cables.

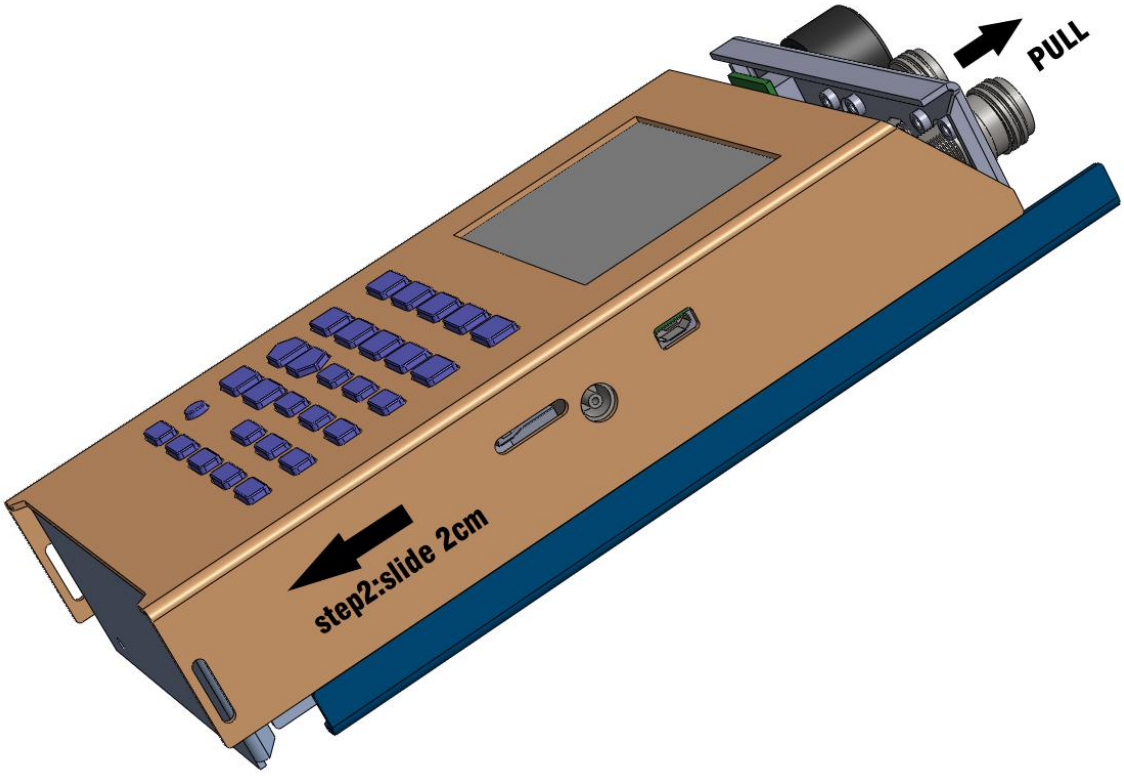

Chart 1-2: Step 2

Step 3: Slightly uplift the cover, and then turn the left.

Step 4: Install batteries. The positive poles direct toward RF connector. If only two batteries are installed, please put them the left-most side and the right-most side(Chart 1-3).

Step 5: check the cable plug, and any deviation is not allowed.

Step 6: Close the chassis in reverse order. Press POWER to check. If nothing unusual occurs, twist screws.

1.3 How to Mount Shoulder Strap

There are mounting points in the tail and in the top, so mounting in the both sides are allowed. If the user needs to use KC901S when carrying,

mounting the strap in the tail is preferred.

Unwind the strap and remove it from the plastic fasteners, thread it through the mounting points and lock in the plastic fasteners.

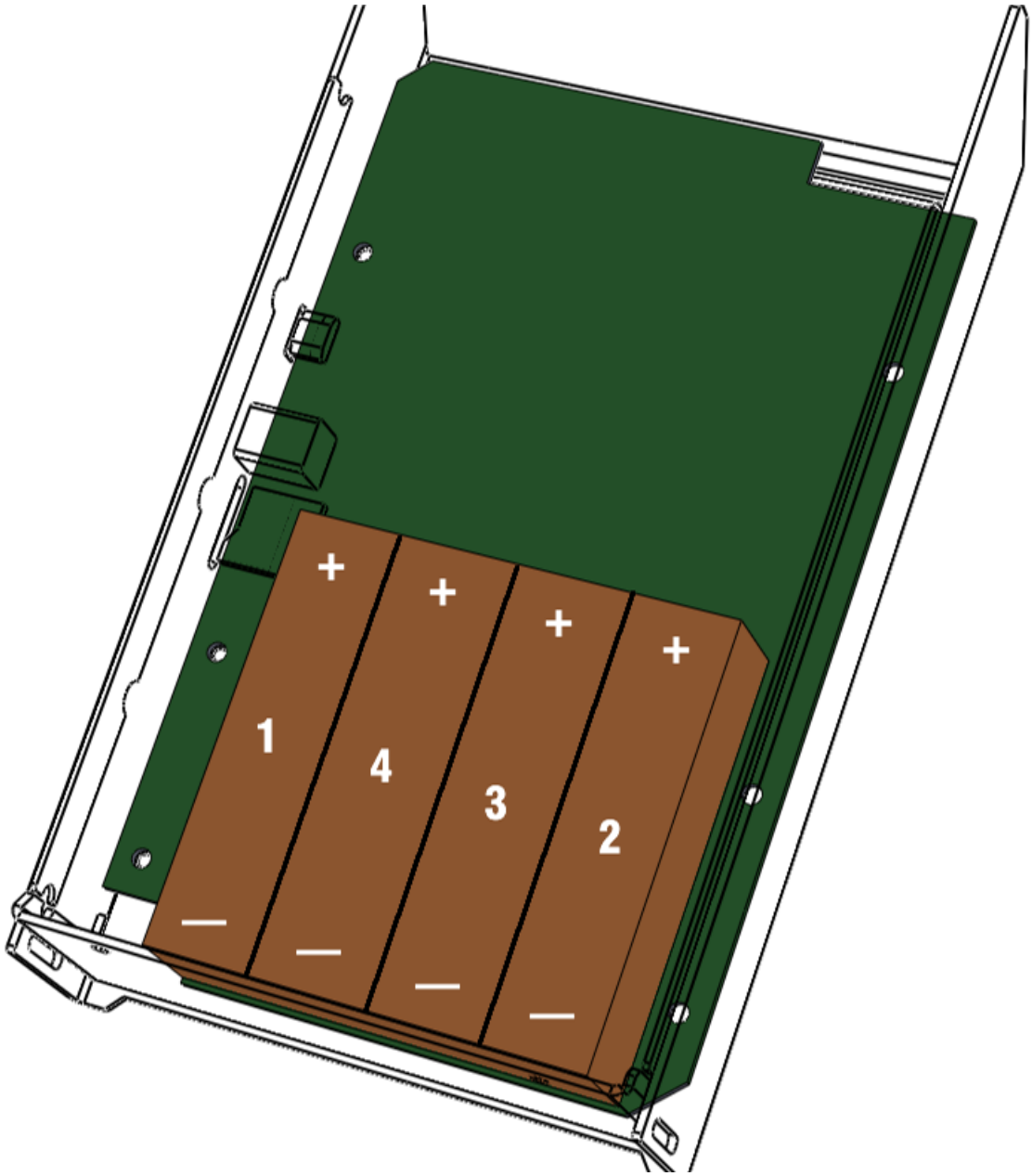

Chart 1-3: Battery Installment

Warning

The standard strap is appropriate in usual occasions. Extra preventing falling measures should be taken when working at heights like towers or ladders.

1.4 How to carry and hold

After the strap is adjusted to an appropriate length, the user should sling over it or wearing it straightly. If KC901S is used in movement, it is suggested that the user hangs it upside down. The strap should be shorten and slung over shoulder when running with it, and prevent injury to the body.

KC901S is designed to be held with left hand and be handling with right hand. When standing to operate, the user holds the left hand at the upper-left, thumbs the knob and places the bottom against the stomach. At the same time, the user connects cables and plays keyboard with the right hand.

The knob is not necessary, because keyboard offers all the functions. “+” “-” equal to rotating knob, and ENTER means pressing the knob. The user holds the bottom of liquid crystal with both hands and plays the keyboard with thumbs.

Fix KC901S in the workbench with screws through mounting points.

Chapter Two　Quick Guide

Designers have tried their best to make users understand easily. Users who have some basic knowledge can handle it in a short time. Therefore, this manual does not demonstrate every detail as usual, but only explains some points that are special.

2.1、Power Switch and Keyboard

Chart 2-1 shows keyboard functional layout of KC901S. Press POWER at the bottom left for 0.5 second to start up or shut down. After the boot, the test mode showing and the main setting are consistent with the settings that were used last time. The menu displays items related with the current mode.

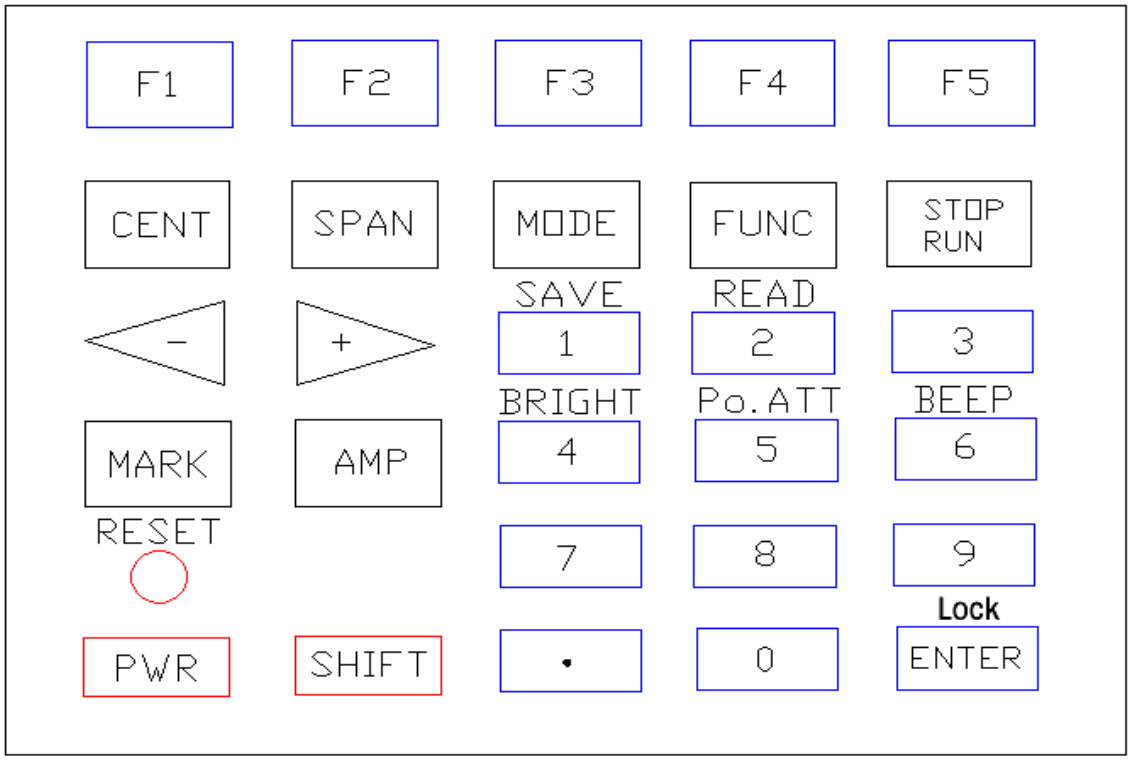

Chart 2-1：The Keyboard

Keyboard's Functions at Level One (Chart 2-1)

Keys	Functions
CENT	Setting scan central frequency
SPAN	Setting scan width（frequency span）
MODE	Entering function selection menu. Repeated pressing means shift between function selection menu and function menu.
FUNC	Entering system setup and exiting system setup
STOP/RUN	Stopping scanning and starting scanning
+、-	Equal of rotating knobs with larger stepper
MARK	Entering the cursor function menu
AMP	Adjusting reference level, trajectory position and range at

	signal source function
POWER	Power shift
SHIFT	Starting functions at level two

Chart 2-1

Keyboard's Functions at Level Two (Chart 2-2)

Keystroke Combinations	Functions
SHIFT+CENT	Setting starting frequency
SHIFT+SPAN	Setting stopping frequency
SHIFT+LOCAL	Disconnecting from the computer and forcibly switching to the local operating system
SHIFT+FUNC	Resetting to defaults
SHIFT+STOP/RUN	Switching to single scan. Under this circumstance each pressing on STOP/RUN means scanning once.
SHIFT+1	Saving data into the memory card
SHIFT+2	Reading curves and settings from the memory card
SHIFT+4	Adjusting screen brightness
SHIFT+5	Adjusting RF output amplitude
SHIFT+6	Key notification tone on/off
SHIFT+ENTER	Locking the keyboard and knobs

Chart 2-2

2.2 Measuring Ports

There are three measuring ports in KC901S. Two of them are external RF ports, and the other is AF port. The most right one is the output port of frequency sweep signal source. The most left one is the input port of tracking receiver. The other RF port inside has been connected to standard load that is replaceable.

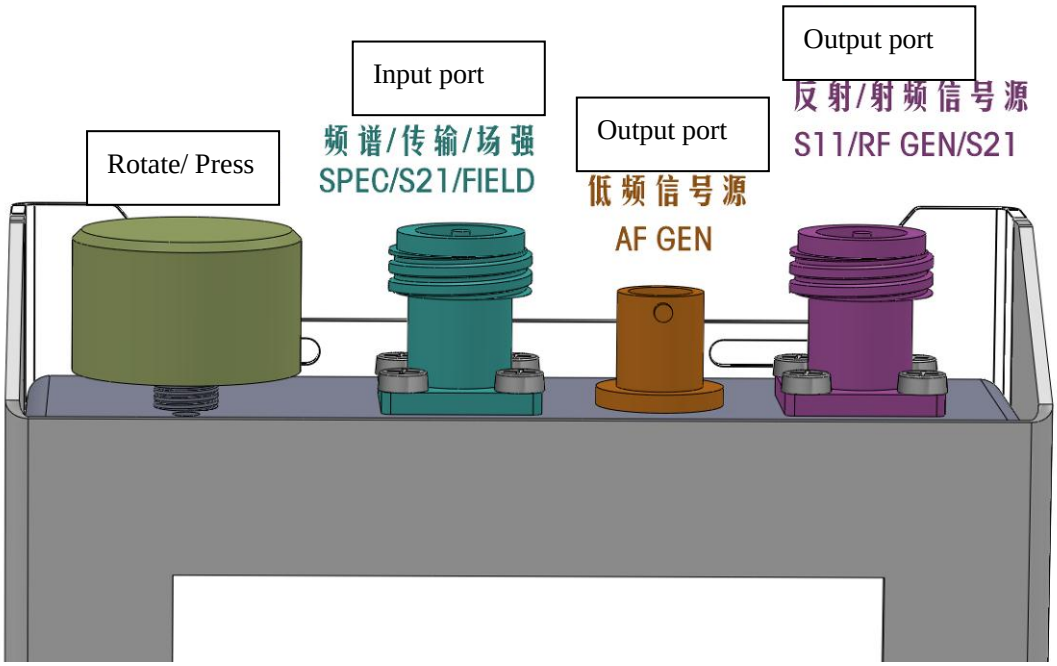

Chart 2-4: The Top ports

Referring to Chart 2-4, Port 1, Port 2 and Port 3 are from the left to the right.

The interfaces of “N ” are precision, so more attention should be paid to protecting these ports, especially S11 in the most right. Careful examination and repair are expected done before well-made connectors are linked. However, it is useless to connect switch-overs that reduces accuracy.

The ports are designed to be pulled and plugged for 500 times. Replace them with new ones as soon as the life ends in case that vector measurement is affected.

2.3 Auxiliary Ports

There are three interfaces in the right as following: Power input, data interface and SD card interface (chart 2-5).

Chart 2-5: The Right Interfaces

2.4 Function Description

Six basic functions of KC901S: reflection test(S11) , transfer test(S21), spectral view(SPEC), filed intensity(FILED), RF signal source (RF SOURCE), and audio frequency signal source (AF SOURCE).

MODE is used to select function. The equipment shifts between function menu and function selection menu by using MODE a couple of times. In

most cases, MODE, equal to “HOME”, turns the screen back to the function menu or function selection menu, so it is frequently used.

The typical application of **Reflection Measurement (S11)** is measuring the standing wave of antenna. The right port should be chosen.

Reflectometer is a kind of vector function with various display modes, selected in FORMAT menu. In Smith Chart and impedance display, the second soft menu from the left provides more display modes.

Access: press MODE and then select （S11）. （FORMAT）in the soft menu decides the display mode of measuring result.

The typical application of **S21** is measuring amplitude-frequency characteristics of filter or amplifier and gains of antenna. The right RF port is to output signal, and the left one is to input.

Access: MODE and then press S21.

Insertion Loss Measurement is a special type of transfer measurement, characterized by high respond speed. As a result, it applies to the fine tuning of filter and measurement gains of antenna.

In order to keep consistence with the operating habits of ordinary receivers, the entry into Insertion Lost Measurement is set in Field mode.

Access: firstly MODE, and then press FIELD, finally press Insertion to make “GEN ON” appear.

The typical application of **SPEC** is monitoring the occupancy and the interference of band and adjusting circuits producing RF signals except

45 MHz。KCSA-R100 is connected to find unidentified emission source.

Access: MODE and then press （SPEC）.

FIELD applies to not only measurement field strength coverage but also searching the amplitude of RF. The port of KC901S is capable of DC isolation so as to externally connect probes to directly search the signal value of receiver and transmitter. It is necessary to match impedance and concatenate attenuator when detecting transmitter. As long as experiences are got, FIELD is used to detect emission the radio station to find fault in time.

Access: MODE and then press FIELD.

RF SOURCE produces a millwatts signal, with an application of transmitting weak signals to the air to determine the sensibility of radio station from a close distance, particularly the sensibility of relay station. It is handier to use the small signal for experienced users. More externally connected attenuators further develop the applications of signal source.

To some extent, RF Source can adjust the signal level with the help of built-in attenuator. The output attenuator plays the role as an amplitude modulator to carry out ASK. If the output attenuator has been applied to adjusting output range, the used decrement which has been used is unable to modulate. As a result, the modulation degree conflicts with the output attenuation. When output attenuation increases, the modulation degree that can be used reduces.

Access: Press **MODE** to select **NEXT,** and then press **RF SOURCE** in menu.

AF SOURCE produces a low frequency signal with a typical function of adjusting the voice-grade channel of electronic equipment. Because AF SOURCE, with various modulation modes, produces the firm output of 50MHz, it is used to adjust RF circuits under 50MHz.

In actual, AF SOURCE can be set in a high frequency (but does not guarantee indices). With the help of its harmonic wave, it can be used to debug the sensitivity of radio stations.

Access: Press **MODE, a**nd then select **AF SOURCE in menu.**

2.6 Local Oscillation Mode

The Local oscillation in SPEC, S21 and FIELD is used to judge mirror effects.

Low Lo: low local oscillation. If local oscillating frequency is lower than the measured frequency, mirror-image jam is caused by the lower frequency.

High Lo: high local oscillation. If local oscillating frequency is higher, mirror-image jam will be caused by the higher one.

If a signal appears in the same position whatever the local oscillating mode is, it is likely to be there already. If it disappears in any mode, it must be false. Appearing on the low Lo while disappearing on the high Lo, the signal frequency is determined by subtracting 90MHz from the appearing frequency. Appearing on the high Lo while disappearing on the low Lo, the signal frequency is determined by adding the appearing frequency and 90MHz up.

If the height of background noise differs in modes, the priority is the lower one.

Local oscillation mode is ineffective below 100MHz .

Notes

Factory calibrations of SPEC , S21 , FIELD are operated under the high local oscillation mode. Under the low oscillation mode, a small measuring error may occur.

2.8 Filed Strength Mode Setting

The actual measurement is the level of input port. By inputting the electrical level and calculating antenna factor, the field value will be got. Antenna factor is mainly relevant with frequency and antenna gain. The equipment should get the antenna gain in order to know the accurate reading of field.

After enter the FIELD mode, the user should press **ANT GAIN** on the

right side. Firstly Select “ +/- ”,and then input the antenna gain on numeric keyboard.

The item in the middle decides the refresh time of reading in levels of FAST, MIDDLE and SLOW. MIDDLE is recommended. The refresh time of Table S not disturbed by the setting is used to observe instantaneous changes of signal intensity.

Warning

KC901S is a network analyzer which does not prevent the reveal of local oscillation. When it is used to observe spatial frequency spectrum and field strength, local oscillation signal will flow backwards to receiving antenna. The strength may arrive -10dBm, and the frequency will be 45MHz higher or lower as the receiving frequency. Consider consequences are caused by the sending signal, and take some measures for protection. Always switch unit off or press stop to prevent other systems from RFI when you have finished measurements!

2.9 Insertion Loss Mode

Insertion loss is the system of single frequency point of S21. It is an essential measurement of S21, whereas only a single point frequency is measured.

After entering the FIELD test mode, **Insertion** on the right of the menu means starting signal input. Get to **GEN ON** into the display of insertion

loss measurement. On the left of the screen, the user will see that the reading is still an absolute level value. While on the right, it has been relative value. Connecting the RF port with measuring cable, the user selects **AUTO CAL** to adjust the relative level value into zero. Next, the user links testing cable to the measured device. Now, the reading on the right side is the value of insertion loss.

2.10 Data Storage

Plug in SD card to save data.

In measuring function, press **SHIFT+ 1** to save current screen capture. Save measuring results and settings in numerical table.

When the computer is connected with USB cable, KC901S will be a virtual USB flash stick. Under such a circumstance, the computer takes over SD card, therefore data could not be saved when the computer is connected.

Under S11 mode, S1P format file as well as all original measuring points should be stored on **（smith chart）** mode.

Chapter Three User Calibration and Preparations before Measurement

3.1 Overview

Normalization of KC901S' ports has been finished before leaving factory, therefore direct use is allowed in most cases. The curve may deviate after power on in the field because of various reasons. In common engineering applications, it is not necessary to calibrate KC901S as long as the measuring result is helpful to analyze and solve problems.

Cables and a great number of connectors, indispensable to measure, cause insertion loss. With time going by and the temperature changing, performance of KC901S may drift. All those disadvantages have negative impact on measurement, the user can do calibration as occasion requires.

If conditions including cables and temperature change, error may occur during calibration. As a result, it is better to make measuring conditions

the same with calibration conditions. In other words, calibration conditions should be as close to measuring conditions as possible.

3.2 Calibration Modes

There are three kinds of calibration modes: factory calibration, system calibration and user calibration.

Factory calibration: high-density calibrations of all frequency ranges have been done before KC901S leaves factory. Calibration scaling algorithm operates a higher-density interpolation. After factory calibration, basic errors can be corrected in any frequency, so generally no calibration is needed. Factory calibration data saved in KC901S can not be reset and directly used by the user. Factory reset function sends the data to system calibration.

System calibration: The same density with factory calibration, but it allows self-operation by the user. Factory reset leads to system calibration data being covered by factory calibration data.

User calibration: calibration can be operated by the user at any time. This calibration whose accuracy is higher than that of factory calibration and system calibration corrects every data point without interpolation error. User calibration only takes effect on set frequency. If setting parameters are changed, the calibration data will make no sense. The final calibration data will be temporarily saved and the data takes effect back to the final setting parameters.

Calibration Operation

Under any display mode of functions of S11 and S21, **CAL Select** in the rightmost of the menu is used to switch among system calibration, user calibration and closed calibration.

Re-select **RE CAL** to operate user calibration if necessary.

Press SHIFT+7 into system calibration in **FUNC** menu.

KC901S prompts operational approach in calibration mode.

3.3 Calibration before S21 Measurement

If DUT is small and light, one of the ports can be directly linked to the equipment, although it is not a good habit. On that occasion, one more cable constitutes measuring system. If DUT is big or the connectors do not match each other, two RF cables are used.

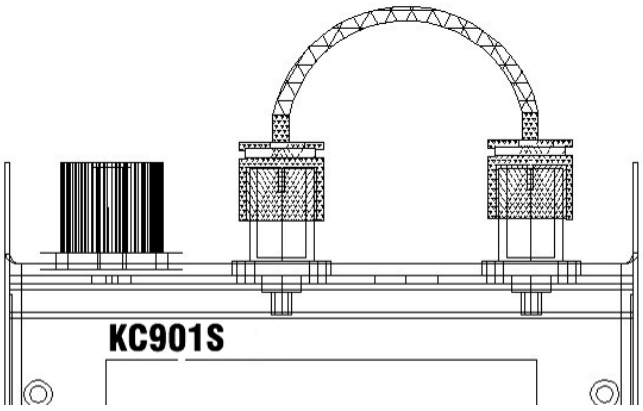

Chart 3-1A: Connection with one cable

As for one cable, it should be bridged over the two ports before measurement (Chart3-1A). As for two cables, them should be connected

with a connector with good quality and bridged over the two ports (Chart 3-1B).

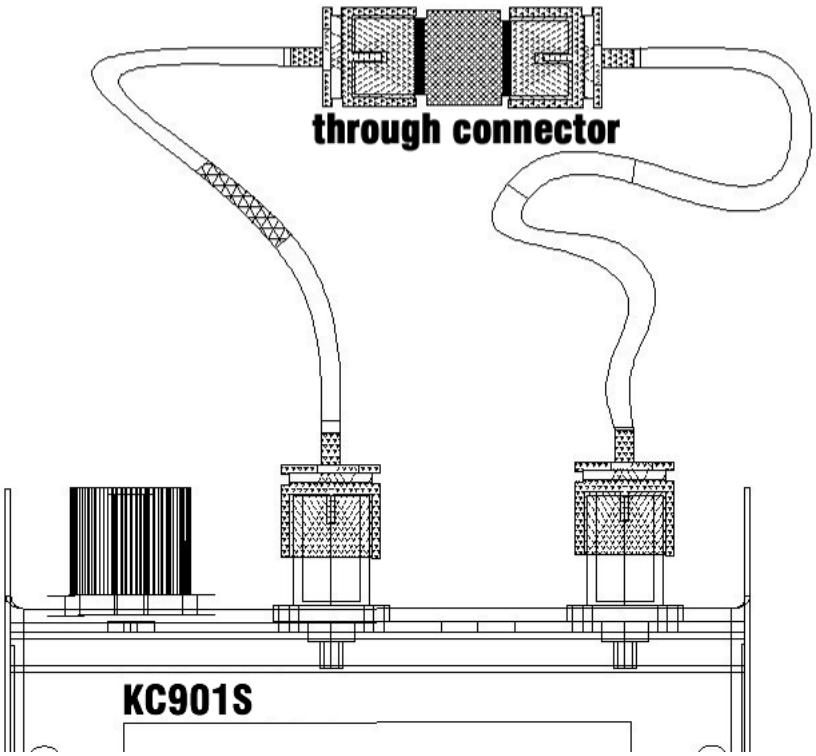

Chart 3-1B: Connection of Two Cables

If many series cables in different locations appear in on system, a one time series calibration is suitable.

When testing power amplifier, connect an attenuator with the output port in series to avoid damage. If it is a little signal amplifier, connecting an attenuator with the input port in series is imperative to avoid strong signal. Before that kind of measurement, it is suggested that all the attenuators should be connected with cables in series to operate calibration.

Follow the hints of **Re CAL i**n function menu to start user calibration.

If frequency is changed after calibration, the system calibration parameters are automatically used.

3.4 Calibration before S11 Measurement

Although there are many display modes in S11 function, only one calibration is necessary, because the same data is being shared in all modes.

It is necessary to operate user calibration in these following cases:

1. In acceptance measurements for important antennas, for example, antennas of radio and TV emission stations.

2. Failing to be connected to KC901S, the port under measurement should be linked with extra cable.

After calibration, please check whether the curves are in the proper position in the open-circuit and loading. In VSWR mode the curve should be higher than 10 in open-circuits, and it should be lower than 1.2 with standard load of 50 Ohms with good quality.

Notes

In the far-end calibration of external cable, if electric length of the external cable is longer than the half of STEP wavelength, scan points should be increased or SPAN should be reduced before calibration. For example, 3MHz stepping equals to 100m wavelength, and the external

cable is not longer than 35m（electric length=the actual cable length /speed factor）

Select **Re CAL** under S11 mode and follow the steps given.

3.5 Reflection Standard Implements

S11 adopts SOL calibration, so three standard implements are needed: Short, Open and fictitious load. During the calibration, these three are considered ideal. KC901S looks for distinctions between ideal value and actual value describing all errors with equations. Therefore, the three standard implements should be as close to ideal conditions as possible.

KC951011/KC951012 is a commonly used standard implement offered by Kexinshe. Users can choose other proper standard implements, being aware that the terminal effect should be small because of no compensation provided by KC901S. The nominal electric length of KC951011/12 is zero. Type the actual electric length in FUNC if you want to use the offset calibrator.

Connect the standard load to the equipment with all the effort. Do not overtighten the connectors.

Standard load is a valuable accessory. Careful using properly keeping and regular checking should be done. Before calibration, please check and clean the connectors to prevent damage from the load or from the

connectors of KC901S..

3.6 Necessary Preparations

3.6.1Check up battery power before brings the apparatus on the go. Start up KC901S to observe voltage. If voltage>8.0V, it means that the rest power is more than a half. It is strongly advised to set auto power off in case that the battery runs out. For long hour's outdoor work, either a charger or a vehicle power supply connector should be used. In wildness, a external battery pack is needed.

3.6.2 KC901S should be carried with a waterproof suitcase to prevent from rain and water. The specialized suitcase for KC901S is advised.

3.6.3 Proper attenuator should be prepared for measuring transmitter and amplifier. When the measured signal exceeds the limit, attenuator must be connected in series.

3.6.4 When testing antenna in places with lots of antennas, a terminal wattmeter is used to measure inductive power of the antenna which should not be more than 0.1W. Many times, several sets of antennas are concentrated on the same tower, inducing strong transmit power through space coupling .Too strong RF power induced from the antenna under measurement are bound to burn down the equipment.

3.6.5 If short-wave antennas are erected near high voltage lines and sub stations measurement induced voltage, not more than 15V, with

multimeter Alternating Current .It is strongly suggested that the shield of coaxial line should be grounded nearby.

3.6.6 If RF signal of circuit board is measured by a probe, outside protective shield of measuring cable should be connected with ground of the circuit. It is dangerous to do suspension measurement that may burn out KC901S and board under measurement.

3.6.7 KC901S can be used during charging, but measuring active devices should be avoided. If the measurement is inevitable, an equipotential bonding between ground of KC901S and ground of DUT is needed to avoid damage from DUT and the equipment.

3.6.8 The standard strap is only suitable for general use. Firm safety rope and packing bag should be prepared for working in height to avoid accidental falling. Set a warning region below the tower when someone works on it.

Chapter Four Common Measurement Methods

4.1 Quick Adjustment of Diplexer

A duplexer is an important part of a repeater. The insertion loss and isolation ratio of a duplexer are directly relative to the overall function of a repeater. KC901S can provide an isolation of exceeding 100db operation range under regular VHF/UHF frequency band conditions and a duplexer can be adjusted at its optimate state under the supervision of KC901S.

Prepared accessories for usage: A fictitious load 50Ω, 2 RF Cables and necessary RF connector assembly.

It is preferred to fix KC901S on the workbench.

Adjustment tools: socket wrench with center hole, screwdriver. Fix the be-adjusted diplexer on the workbench if possible.

Special setting: employ intermediate speed or high speed（FUNC，

Speed）in initial adjustment. Employ **low speed** or insertion loss mode in precise adjustment of notch points.

Here is an introduction of adjustment steps by taking six-cavity duplexer as an example that works on the principle of notch filter.

Adjust the KC901S to S21 mode, and adjust the center and span of the apparatus so that frequency band can cover the original frequency and new frequency of duplexer. The AMP can be adjusted to 0dB or +10dB (change the AMP and ordinate span according to the position of curve. When the ordinate span reaching 20dB/div). Then start system calibration. Move mark1 and mark 2 respectively to near the new receiver frequency and transmitter frequency.

Please use the equipment to measure the insertion loss (S21) RF cable first, then sway connection cable and connector lightly to look at if the curve dithers while measuring in order to make sure there is no poor contact. The insertion loss of cable should be as small as possible. The quality of cable should be good enough to provide with excellent screen. Hang cables in the air to observe the position of noise floor for a minimum of -90dB at 450MHz.

Clean the socket of the duplexer, then connect the output port of KC901S to the TX in-port of duplexer(usually marked “high”), next connect the in-port of the apparatus to the ANT(antenna) port, and connect the fictitious load to the RX output port (usually marked

low)(chart 13).

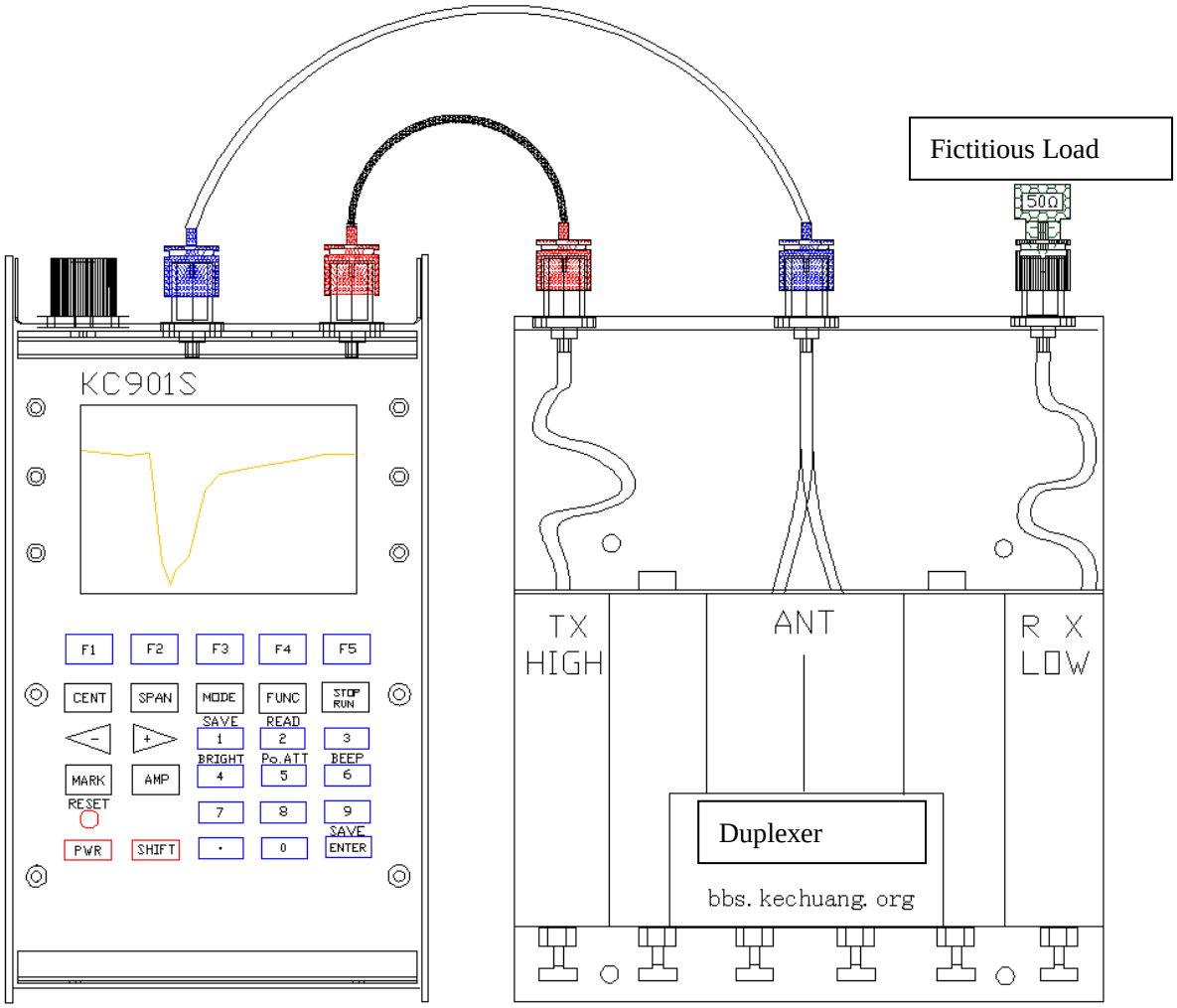

Chart 4-1：Example for Connection Method of Duplexer Measurement

Adjust the three screws near the TX port to move the trough to mark1 indicated position until they overlap. Then take turns to slightly adjust screws under the supervision of S indication until the reading is the minimum (the maximum negative). Normally, the reading should reach or exceed-60dB. At this moment, mark1 means the HIGH isolation ratio and mark2 means the HIGH insertion loss

Connect the output port of KC901S to ANT port of duplexer, still connect the in-port to the RX port, and connect the fictitious load to the TX port. Adjust the three screws near the RX port to move the trough to mark2 indicated position until they overlap smoothly. Then repeatedly adjust the three screws from center to RX side until the mark2 indication is the minimum (the maximum negative). Normally, the reading should reach -60dB.

If necessary, reset the CENT, REF of the equipment and reduce span so that the new frequency curve can be partially enlarged. Adjust the mark1,2 position more accurately At the meantime, connect measuring cable with straight thread connector to go on with S21 through calibration.

Reconnect the output port of equipment to TX port of duplexer, and then link the in-port to ANT port, finally connect the fictitious load to the RX port. Next repeatedly adjust the three screws from middle to TX side to keep the mark1 minimum reading. Normally, the reading should exceed -70dB, good quality duplexer can reach -90dB. At this moment, the S reading of Mark2 means the insertion loss of duplexer transmit signals.

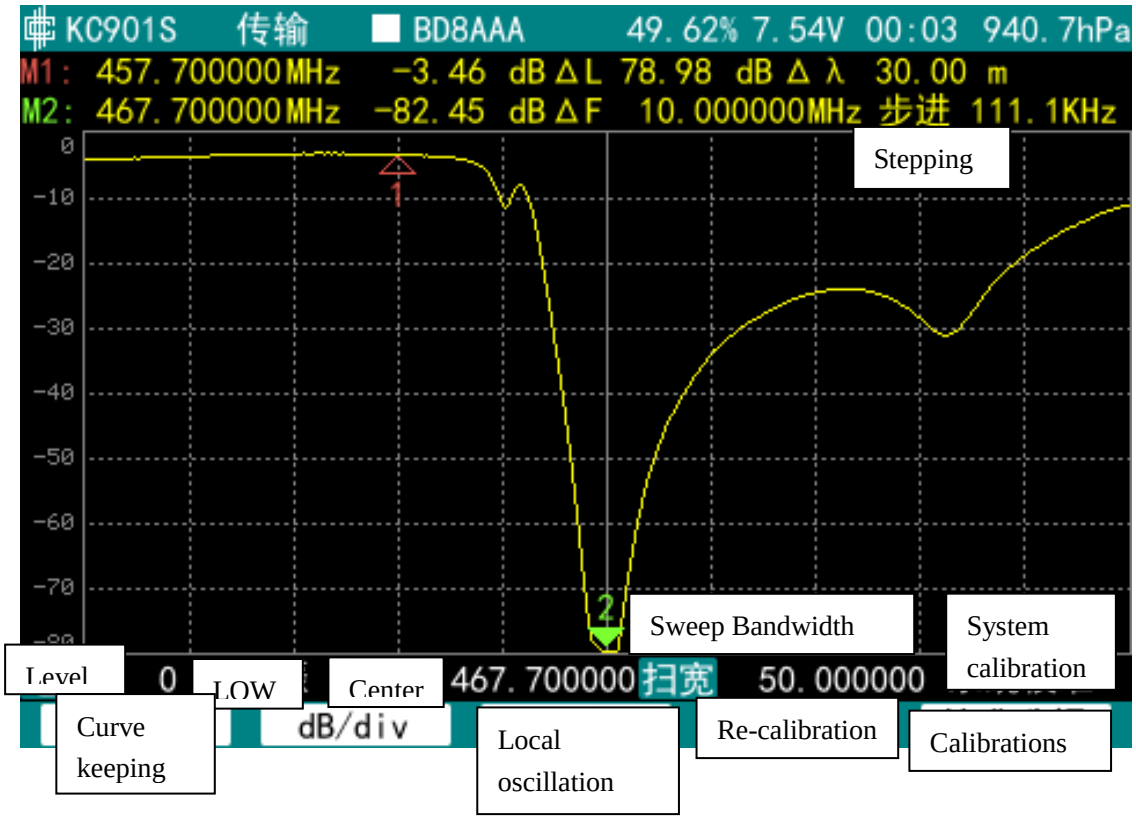

Chart 4-2: Typical curve of LOW side of duplexer, uncompensated cable loss

Connect the output port of KC901S to ANT port o. Then connect the fictitious load to the TX port. Slightly adjust the three screws near the RX side to keep the mark2 minimum reading. Normally, the reading should be less than -70dB, Read the S reading of mark1, which means the insertion loss of duplexer transmit signals.

Please switch local oscillation mode, choosing the lowest way in the curve bottom. Adopt different local oscillation modes when measuring both parts of the duplexer.

Sometimes the two sides reading data of duplexer affect with each other, so it is necessary to adjust the three crews repeatedly until the restrain

reading data reach or exceed -70dB.

Do not adjust the restrain curve of the duplexer into a too sharp shape. Reduce SPAN to 1MHz, observe the bottom of the curve, the width should exceed 100 KHz. If the curve is too sharp, the cusp of the curve may move out the used frequency while the temperature or the match condition of ANT is changing.

If there is a contradiction between insertion loss and attenuation, attenuation on the RX side should be primarily guaranteed. Appropriately turn down the transmit power so that to reduce the requirement for attenuation. This should be abided by the principle of “Adjust TX toward inside and Adjust RX toward outside”; try to keep balance of insertion loss.

For the duplexer whose coupling degree can be adjusted by screw, adjust the coupling screws. If all adjustable screws are not long enough, change them to long screws. If the entering length of screws is too long, the Q data of duplexer will be lowered. Dismantle the extended solenoid of the duplexer in case of emergency.

If the insertion loss can not be turned down, S11 measurement can be tried (connect the fictitious load to the non-tested port rather than to the in-port of the apparatus). Tentatively adjust and compare the reading with others, try to control the SWR under 1.5dB.

Please screw and fix the screws during the adjustments to keep the

reading data stable.

Notes

Port match has influence on the rejection characteristics. Measuring results are influenced by the type of apparatus used and the relationship between the equipment changed and ports of the deplexor. The antenna impedance changes as repeater is different, so practical performance falls behind expectation. Draw lessons from practical performance after installing repeater in the first adjustment.

Connect in tandem an attenuator (around 10dB) in the input port to improve the match. Increase output attenuation（SHIFT+Po.ATT）to 10 or 20dB, which is helpful to reduce influences on measuring results by non-linearity.

4.2 ANT Measurement

Warning

It is possible for the output port of KC901S to a maximal outputs 10dBm （10mW). KC901S transmits the output into the air in ANT measurement. Po. ATT increased can reduce emission, but Re CAL should be done.

4.2.1 SWR Measurement for ANT

When ANT is to be measured, the equipment should be adjusted to S11 mode, and Format is VSWR. Settle down center and span, the operator should be away from ANT.

The SW of AN is easy to be affected by the surround environment. So it is better to choose a wide outdoor field, such as a rooftop. The length of the feeder should be as short as possible, disconnect the feeder from the end which connects the ANT. Contain the feeder for calibration.

4.2.2 Cable Deduction

In measuring antenna, occasionally, calibration can not be done on the port of antenna, so the influence from feeders can not be automatically dispelled. On this occasion, reflection parameters of antenna send the condition of cable to KC901S, the equipment deduces cables.

In FUNC menu, there are two set items: cable electric length and cable attenuation. Cable electric length =Cable length/ velocity factor. Cable attenuation is estimated based on the attenuation at unit length presented in technical manual and cable length.

The two items above are both single-pass parameters.

Cable deduction is employed in low frequency under 30MHz.If conditions permit, operate user calibration on cable's far side, because the equipment can eliminate the influence of cable.

4.2.3 Antenna Impedance Measurement

KC901S works out the impedance of antenna by measuring amplitude difference and phase difference of incidence signal and reflection signal. Because both amplitude difference and phase difference are related to fe**eder. Operate user calibration in the feeder's far side** unless antenna

is directly connected with the equipment.

The impedance is greatly affected by installation of antenna. During measurement, make the installation condition get as close to operating environment as possible. For antennas installed in interphones and routers, shells should be contained during measurement. Antenna of router should be measured together with the mainframe. Firstly, the original cable is cut from inside of router. Secondly add a measuring cable for the antenna. Thirdly, the side close to antenna passes through magnetic ring. For example, measuring in calibration, these parts of cables should be contained.

At low frequency, if cable is not included in calibration, set cable's electric length to deduce its influence. At high frequency (for example 2400MHz), it is not a reliable solution.

4.2.4 Measurement for Antenna Gain and Antenna Pattern

Utilizing the function of S21 (or insertion loss) of KC901S, together with another set of antenna to obtain the horizontal antenna pattern or back ration. If there is another set of known-antenna gain antenna, then the antenna gain can be measured.

Measuring environment: black rooms or standard measuring locations. A level open area, the size should be larger than 20 times of the wavelength. For the antenna of over UHF frequency range, smooth and level rooftop can also be the measuring environment.

Equipments: 2 antenna supports, one has a rotary table, if the condition is limited, rotate the antenna support manually. The height of the antenna supporters should suit to the designed usage conditions of antenna. By principle, the height should be longer than the 2 times of working wavelength. It is better if the distance between the two antenna supports is larger than 10 times of the working wavelength.(For example, the very long working wavelength of antennas of short wave, it is allowable to appropriately decrease the distance between the two antenna supporters). If necessary, take more times of tests by changing the distance, and take the average number to eliminate the impacts cause by ground reflection. According to the distance between the two antenna supporters, prepare long enough cables; try to keep the equipment and tester a distance more than 10 times of wavelength form antenna. Besides to-be-tested antenna, prepare another known-antenna gain antenna for reference.

Method: Install measuring antenna and to-be-measured antenna on the supporters (Chart 4-3). At first, make certain direction of to-be-measured antenna (predict the main flap direction or mark a direction) aim at the measuring antenna, then set the apparatus S21mode and input measuring frequency. Normally, choose the smaller span such as 1MHz. Furthermore calibrate the apparatus, turn the curve sheet into zero. Next, rotate the to-be-measured antenna with a certain angle at intervals. Write down S reading (dB number). At last, draw dots on the angle- antenna

gain graph thus to obtain the direction graph of the to-be-measured antenna.

The above measurement can also be done by utilizing insertion loss measurement mode. At first, set FIELD mode, select （Insertion） to start insertion loss measurement, then press Auto CAL button to turn the insertion loss reading into zero. The insertion loss reading means the same as the S reading in S21 mode.

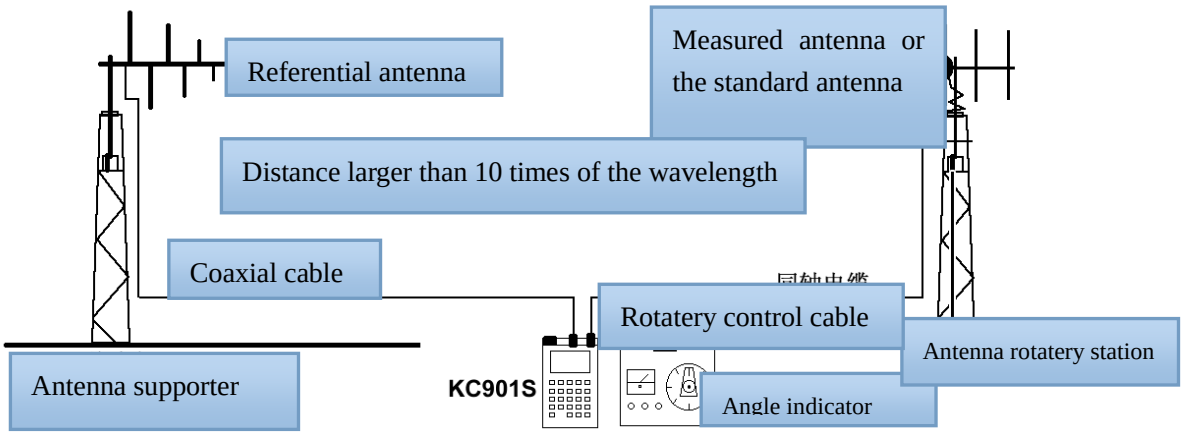

Chart 4-3, Antenna gain measurement in an open area

In the measurement, press SHIFT+1 to save data to analyze afterwards. In order to decrease operation complexity, KC901S automatically names files in chronological order. The user can make notes of starting time and quantity to avoid confusion.

If the user wants to measure the antenna gain, it is necessary to install the known-antenna-gain antenna for reference unto the to-be-measured antenna supporters, adjust the orientations of the referential antenna and testing antenna(make the referential antenna's given direction aim at the measuring antenna), then go on user calibration under S21 mode. Then

keep the settled reading of the equipment invariant, and then change the referential antenna into the to-be-measured antenna to measure, write down the reading of different angle S reading. At this time, the obtained reading plus the referential antenna gain, this is the antenna gain of different angles.

If many frequencies direction graphs and antenna gains should be measured, repeat the above steps by changing the different frequencies.

During measurement, do not change frequency, otherwise user calibration loses efficacy and the data lose its relative significance. While measuring, the user keeps away from the antenna, if it is necessary to rotate to-be-measured antenna manually. After rotation, the user should walk away from the antenna and then read the reading data.

Use two KC901Ss; setting one signal mode, another one FIELD mode, this helps to build a single frequency point scalar net measurement system, used in the setting of 2 far distant antennas. Of course, the one KC901S for transmit can be replaced by a transmitter of good stability. If broader measurement range is needed in other S21 measurements, two KC901Ss can be controlled by one computer.

4.3 Measuring Electric Length of Transmission Line

KC901S precisely measures the electric length of transmission line terminal in short circuit or open circuit. In S11 mode, take a smooth and periodic part of curve to measure frequency difference（Δλ）of a circle of

phase shifting in PHASE display. The electric length= Δλ/2.Certainly, the electric length= Δλ (phase shifting of 180°）/4. Additionally, the electric length can be got from the frequency difference of double 360°phase shifting.

Besides, deal with the derivatives based on the stored data on computer to get group delay. In this way, electric length will be calculated. Take narrower SPAN or more scan points to avoid phase aliasing.

Take SPAN as narrow as possible to make the curve experience one or two periods in order to get a higher range resolution.

It is necessary to operate user calibration on the edge of transmission line when connecting transmission line under test via patch cord. The compensation of cable length in FUNC menu should be set as zero.

In Chart 4-5, electric length=1.432m，cable length=1.005m. It can be calculated that velocity factor is 0.7018.

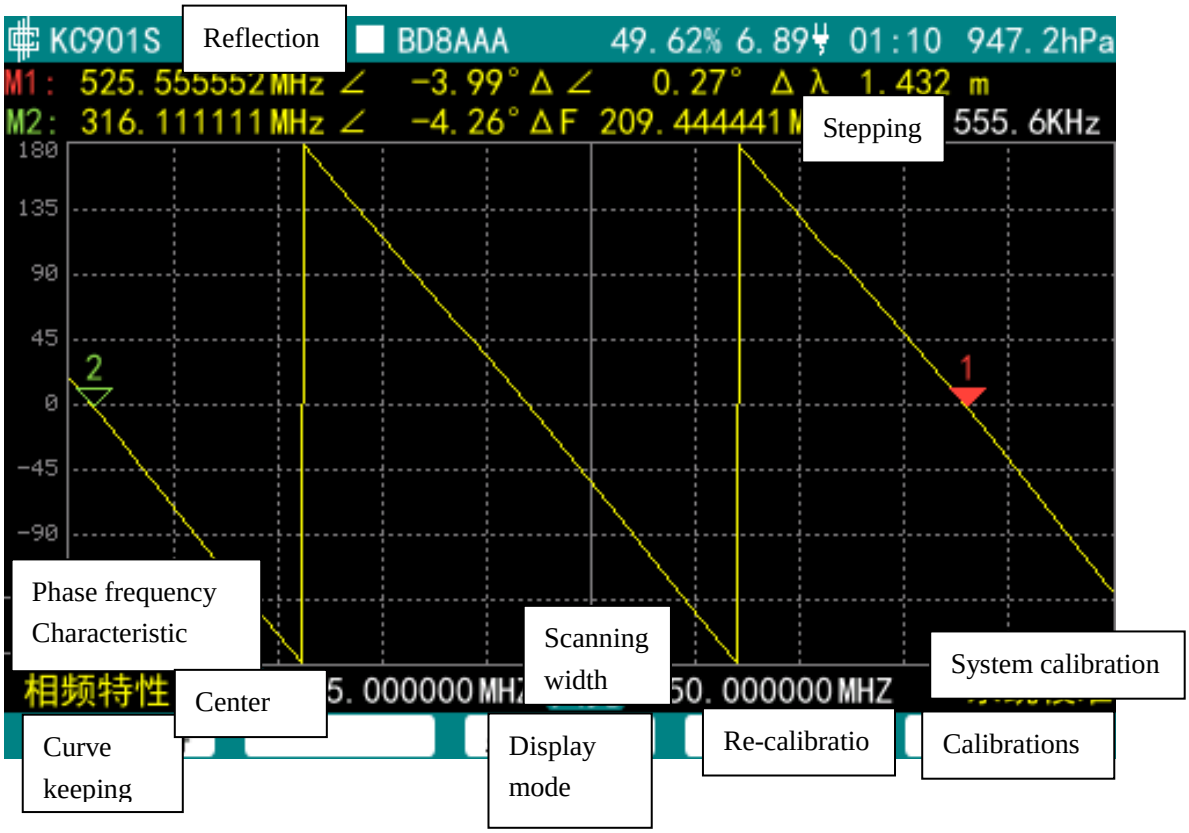

Chart 4-5: Measuring Electric Length in Phase Frequency Characteristic

In short-circuit and open-circuit, cable loss is about half of return loss. When cable is connected with antenna, return loss at non-working frequency can be used to estimate cable loss.

4.4 Spectrum Display

KC901S strengthens properties of the input channel to provide the basic spectrum display.

Warning

The input port of KC901S permits a limiting level of +20dBm and a limiting DC voltage 15V. The apparatus is bound to get damaged if the standard is disobeyed. When measuring transmitter and amplifier, an appropriate attenuator must be concatenated to control the limiting values.

Notes

+20dBm is the limiting level not damaging the apparatus, which does not mean that KC901S is able to measure the signal at +20dBm. The proper level is less than +10dBm for the sake of accurate measurement.

KC901S is a network analyzer, so the measuring result of spectrum is only for reference.

Mirror image interferes with the spectrum mode. Connect an appropriate filter to the input port in series to operate monitor function. When measuring shortwave spectrum, use **（Local Mode）** to identify image response. Cascade KC9504.01 of 120MHz to eliminate interference from intermediate frequency feed-through.

If the concerned span is too narrow, set CENT and SPAN according to need. Set AMP based on intensity of the signal under measurement. AMP ＜-40dBm when searching for weak signal. Unless conditions permit, scan piece by piece in narrow span.

4.5 Detecting Interference Source

In bands no interfered by mirror image, use KC901S with directional antenna to detect interference source by oto method.

After entering spectrum mode, set center at frequencies probably interfered. Span is set at small value (like 1MHz). When interference is weak, REF should be set to -60dBm. Do not stop Adjusting direction of

antenna and polarization mode to detect interference signal until the most obvious bulge emerges in the center of spectra. After measuring the directional azimuth angle of antenna by magnetic compass trace out directional line. In the same way, get another line at another point. The intersection point of two lines is likely to be where the source locates.

Preserve an angle of 60—120,(close to 60)between the linking line of two measuring points and one directional line(Chart 4-4) .

Keep the measuring point in height to avoid being blocked by buildings. When approaching to the source, adjust AMP based on the intensity or adopt the field mode. Move in the direction of the strongest interference and keep approaching to the source. Generally speaking, the amplitude should be over 70dBμ（-37dBm）when approaching to the source.

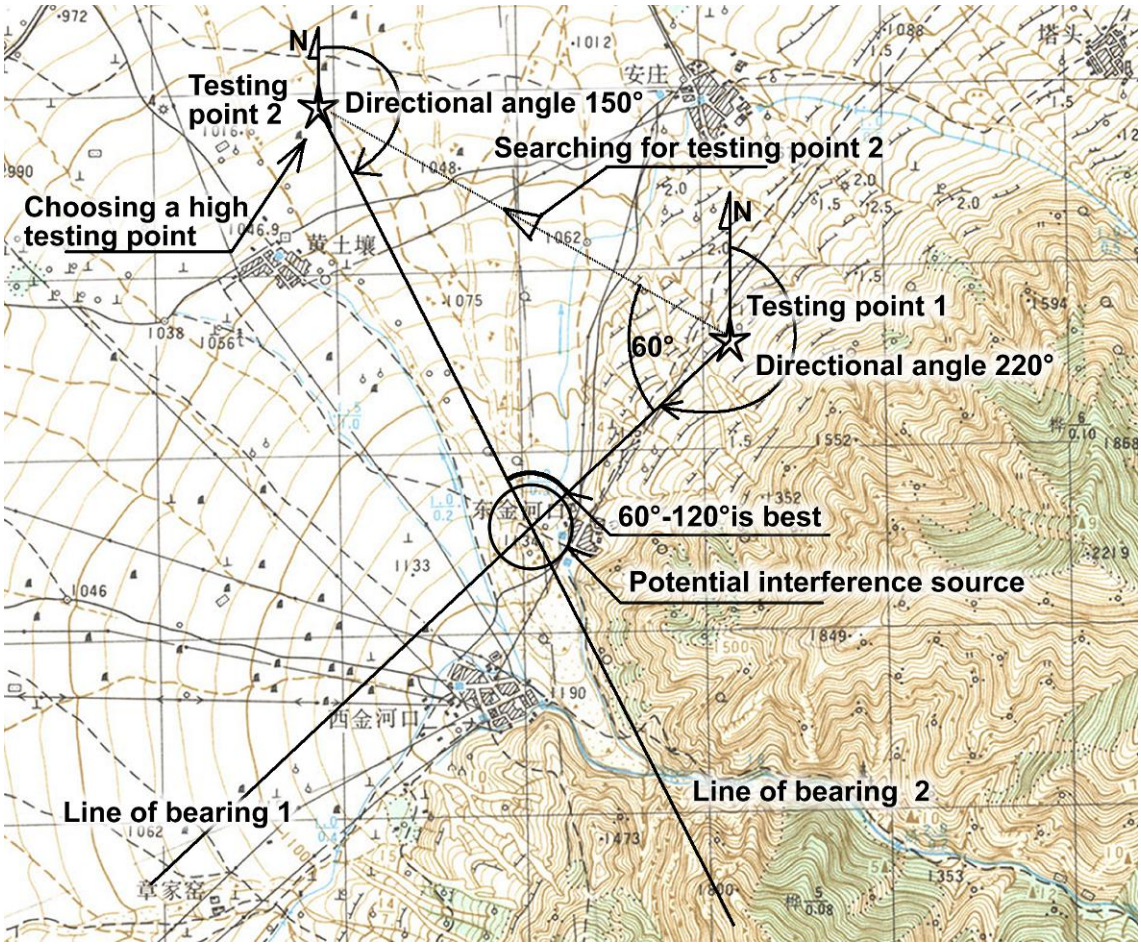

Chart 4-4. An example of cross location and diagramming method

Connect a band-pass filter between the equipment and antenna to the reliability of measurement. In a helical structure or cavity structure, band-pass frequency of the filter can be adjusted under the supervision of KC901S before using. When measuring weak signal, it is practical to connect a low-noise amplifier between the filter and the equipment.

Locating the interference source is a task combined with theory, experience and technology no matter what kind of equipment is used. Practices increase efficiency. Because of diffraction and reflection of signal, there are many illusory directions in measurements in cities and mountainous areas.

*For narrow-band signal, higher response speed is got when the user detects interference source in FIELD mode.

*FIELD function is used to measure emission field strength around the antennas of radio station. IF gain which may be damaged by strong signal because of wrong setting in SPEC function is manual set.

*Connect a filter of narrow band pass in series to detect interference with FDM system of 45MHz frequency difference for fear that the local oscillation reveal interferes with communication system.

Warning

Without permission, do not use KC901S to monitor the spatial frequency spectrum of non-working frequency. It should not be revealed even it is measured by accident.

Chapter Five Maintenance

5.1、How to Clean Screen, Keyboard and Ports

Please remove protective films from the screen. The glass screen protector is replaceable, so there is no necessary of pasting screen protector which could reduce visibility under the sun.

Please clean the dirty screen and keyboard with wet tissue firstly and with gauze later.

It is a proper way to sweep away the dust inside with 0.2MPa compressed air after dismantling the control circuit board. On occasion the glass and rubber pad should be replaced.

RF connectors shall be frequently cleaned with dry swap first and with anhydrous alcoholic swap later. End faces of core needles and ledges outside connectors are supposed to be wiped luminously. Twisted tissue is a good tool to clean up the holes on core needles.

warning

The charger and batteries must be removed prior to dismantling circuit board. The user actions of dismantling enclosure and circuit board to install batteries and of cleansing screen do not change the term of maintenance. However, any fault made during this process is not guaranteed.

It is not allowed to cleanse screen, keyboard and knobs with organic solvent.

5.2 Other Matters Needing Attention

1. The equipment should be settled inside in a pack or a suitcase during the long distance transportation. A baldric should be used while on-the-go to avoid falling off, collision or putting together with other construction tools. The connector must be removed during transportation and carrying unless necessary. It is forbidden to use measuring cable as handle.

2. Flexible cable should be used to switch while measuring heavy devices or connecting thick feeder.

3. While installing the plug-ins, please point the position, plug in carefully, shake lightly and screw slowly. Screw the thread tightly when feeling the core needle has been already inserted into the core hole. Both hands should operate to screw the thread, with one hand holding the body part of the plug-ins to avoid revolve of the plugs, another hand revolving the exterior helicoil. Revolve of the whole plug should be avoided, otherwise lifespan of the RF connector will be dramatically shortened and also cable will be damaged. Pay attention to check before stalling plug-ins at construction. If the core needle protrudes too long, curve or lant, stalling should be done after repair of the core needle, otherwise the interface will be stretched.

4. The equipment should be avoided of being exposed in the rain or water inflow. The equipment should be put inside the suitcase or be prevented from rain in rainy days. Turn the power off immediately if clean water flows in; fling out the water though the bottom part and blow dry it in a ventilated place. Waterproof suitcase is suggested to be equipped if the equipment is often in the open air.

5. The equipment should be sealed with plastic bag if the operator enters in a room with central heating from the outside in winter. If there is dew formation on the apparatus, firstly KC901S should be put near the radiator to be dried, and then the equipment can be powered on. But it is necessary to pay attention to the temperature.

6. It is no good for maintaining good battery life if power shortage warming appears or power off. A long-term floating is banned. When the charger is connected for a long time in work, batteries should be removed.

7. When KC901S lies idle, the battery should be 8.0V for storage. During that time, it is better to annually charge once at least to 8.0V. It is suggested to remove batteries before a long-term storage.

8. Do not keep the equipment close to high-powered transmitting antenna. Do not kept interphone close to transmission.

9. Ionizing radiation may do harm to the equipment. In addition, neutron irradiation makes irreversible damage.

10. The USB socket is fragile. Use Soft data cables to avoid lateral force.

11. Period of verification of KC901S is one year. It is better to send it to manufacturer for calibration and verification.

12. The warranty period for the host is one year. Any exterior damage which is caused by normal wear and tear or artificial damage is not included in the quality warranty after delivery.

12. It is forbidden to dismantle the case arbitrarily during warrant period. Damage caused during the tear-down is not included in the quality warranty. Attempt to disassemble RF components can void the warranty.

Chapter Six Technical Notes

6.1 Measuring Principle

The measuring circuits of KC901S consist of one signal source and three receivers.

The signal source is divided into two frequency bands: the one lower than 50MHz (AF signal source lower than 50MHz） is directly produced by DDS; the other higher than 50MHz is produced by PLL. The two frequency bands pass through one gating switch converging into one RF signal.

Two of the three receivers are relevant applying to S11 measurement, while the other applies to measuring S21 and frequency spectrum.

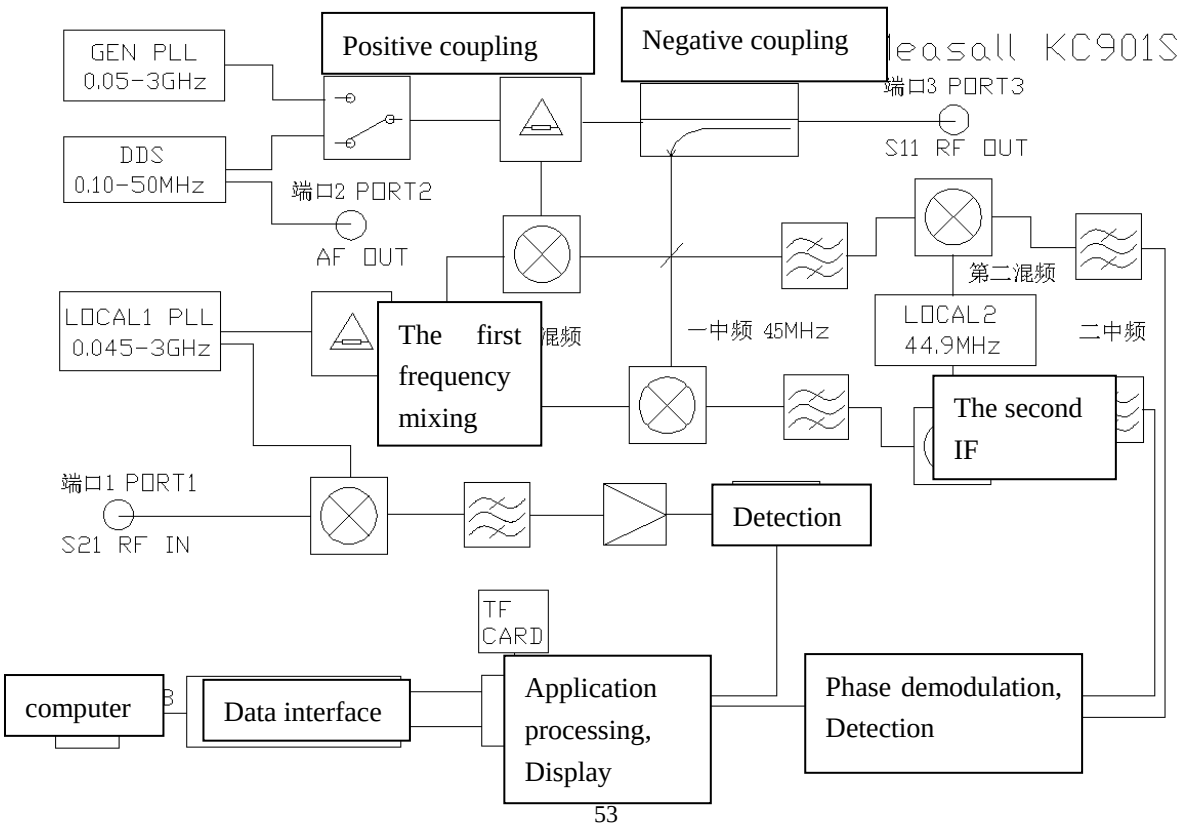

Chart 6-1. The Functional Block Diagram of KC901S

When S11 is measured, CW produced by signal source gets positive signal from positive splitter prior to getting negative signal from the bridge, and finally it output from port 3. Phase difference and amplitude difference are got after the positive and negative signals enter two receivers separately, via double-conversion, to phase demodulation and detection circuit. Adopting counting method to do digital phase distinguishing, KC901S measures amplitude with logarithmic detector. All data about S11 is got from phase difference and amplitude difference.

When S21 is measured, signal source still output from port 3 via the bridge, but no detection is taken before it passes through DUT. Next, the signal inputs into port 1 to undergoing a frequency conversion and an IF amplification. The absolute value of level is got via amplitude wave detector. The result of transmission measurement is got after a comparison between testing data and calibration data (transmission data recorded by KC901S).

In AF SOURCE function, DDS is directly used to output AF signal. KC901S adopts digital synthesizer with clock frequency of 400MHz, so AF SOURCE function is able to generate signal over 50MHz and supports FM with guaranteeing index.

6.2 Charging Time and Time of Endurance

The rated charging current of the batteries is 1A. The battery capacity determines charging time. A commercial battery with the maximum capacity of 3.4Ah, the charging time will be 4/2×3.4≈7h if all four batteries are installed. If two batteries are with a capacity of 2.2Ahm, the charging time will be 2.5h. KC901S automatically stops charging once the signal voltage is 4.2V and the total voltage is 8.4V. When the temperature is either too high or too low, the charging rate will lower down.

KC901S'time of endurance is determined by battery capacity and function operating. For different functions, the electricity consumption varies itself. Under S11 or S21 mode, signal source and many receivers should be started, so the electricity consumption reaches its highest peak. Under SPEC , FILED, and SOURCE modes, only signal source and one receiver should be started, so the electricity consumption is lower. When KC901S is in STOP, the whole RF circuit is closed, and only CPU and display consume power.

When four batteries are installed, the brightness of screen will be 20% and the temperature will be 15℃. Chart (1) shows time of endurance. High or low temperature and the low actual battery capacity reduce time of endurance.

Chart（1）	Time of Endurance（hours）

Function\capacity	2200mAh	2600mAh	3100mAh	3400mAh
S11	3	4	5	5.5
S21/Insertion Loss	3	4	5	5.5
SPEC/FILED	5	6	7	8
RF SOURCE	5	6	7	8
AF SOURCE	6	8	10	12
STOP	12	15	19	21

If only two batteries are installed, the discharge rate will be larger. Thus, time of endurance will less than the half of the time above.

6.3 Technical parameters

Frequency range:

Transmission measurement 100 KHz…3GHz

Reflection measurement 250KHz……3GHz

Output level (typical value):

+3dBm or 2mW（1MHz——2GHz）

+0dBm（2——3GHz）

Variable attenuator: 0—30dB

Input sensitivity:

superior to -107dBm or 1μV（300KHz—1GHz）

superior to -87dBm or 10μV（1——2.2GHz）

Damaged level:

all the RF ports DC15V，+20dBm

Measuring range 0f S21 (typical value):

110dB（1MHz——1GHz，about 60dB in 100KHz ， about 110dB in 435MHz）

70dB（1——3GHz）

Resolution:

Frequency is 1Hz, level is 0.1 dB, phase is 0.01 °

Level uncertainty:

(Typical value,@25℃,battery voltage≥7.5V)

±1.5dB（spectrum measurement，REF=20dBm），±3dB（spectrum mode and field mode）

±（0.3+0.05L）dB（in S21 measurement，when calibration is directly connected and insertion loss L≤60dB）

0.05dB（zero adjustment drift of insertion loss mode，5 min warm-up，every hour）

+1dB，-3dB（loss, SOL calibration, 3dB≤RL≤25dB）

Absolute directionality (typical value, inferior to about 90% interval, superior to little interval) ：

18dB（3MHz—15MHz，2GHz——3GHz）

20dB（15MHz—2GHz）

Relative directionality（When SOL calibration is done and directivity of calibrating device is superior to 48dB)

45dB（3MHz—2.5GHz）

25dB（1MHz—3MHz，2.5GHz—3GHz）

20dB（300KHz—1MHz）

Phase uncertainty（1min warm-up，continuous mode）

2°（3MHz—1GHz）

5°（1GHz—2.5GHz，1MHz—3MHz）

8°（2.5GHz—3GHz,300KHz—1MHz）

Internal bridge directionality（typical value）：

18dB（3MHz——15MHz，1.5GHz——3GHz）

30dB（15MHz——1.5GHz）

Frequency stability:

±1ppm/year@25℃

Supply voltage:

11.5V…32V（external power ）；7.2…8.4V（battery）

105V…230V，50/60Hz（power adapter input）

Battery endurance（typical value，@25℃）：

7hours （spectrum ,field, signal source）；5hours （S21 or S11 includes insertion loss test）

20hours （in STOP mode, Screen brightness is 10%）

Humiture range：

-40……65℃（external power source, depends on temperature characteristics of battery when power is on）

no condensation and no frosting

Size：

200×114×46mm（length, width , height ）

weight（including battery）：

Net weight of host <1.2kg

Total weight ≈2.0kg

Notes：All indexes are measured in low speed mode and zero attenuation of output. Some unusual data points may go beyond technical parameter chart.